

**REMARKS**

**I. Introduction**

In response to the Office Action dated December 7, 2009, Applicants have amended claim 9 to overcome the § 112 rejections. Applicants have been careful to avoid the introduction of new matter.

**Interview Summary**

Applicants appreciate the granting of an interview with the Examiner on May 5, 2010, during which an amendment to claim 9 was discussed. During the interview, the Examiner agreed that the proposed amendment would overcome the § 112 rejection of claim 9.

For the reasons set forth below, Applicants respectfully submit that all pending claims are patentable over the cited prior art references.

**II. The Rejection of Claims 14-18 Under 35 U.S.C. § 102**

Claims 14-18 stand rejected under 35 U.S.C. § 102(b) as being anticipated by JP 2001/015012 ("JP '012"). Applicants respectfully submit that JP '012 does not anticipate the pending claims for at least the following reasons.

With regard to the present disclosure, independent claim 14 recites a carbonaceous material projection structure comprising a plurality of carbonaceous material projections provided according to a predetermined arrangement, a density of the carbonaceous material projections being not less than 4 projections/ $\mu\text{m}^2$ , the plurality of carbonaceous material projections being formed by etching using a mask, and tips of the projections being smaller than roots of the projections.

In addition, independent claim 15 recites a carbonaceous material projection structure comprising a plurality of carbonaceous material projections provided according to a predetermined arrangement, each carbonaceous material projection having an approximately conical shape, the approximately conical shape being formed by etching a mask, and an apex angle of each carbonaceous material projection being not more than 39 degrees.

One feature of the present disclosure is that the carbonaceous material projection structure comprises a plurality of carbonaceous material projections that are formed by etching using a mask, the tips of the projections being smaller than roots of the projections. For example, as shown in Fig. 1 of the present disclosure, a metal mask 13 is used to form the conical carbonaceous material projections 14 whose tips are smaller than their roots. As a result of this feature, the carbonaceous material projection structure can emit a large amount of electron current.

It is alleged in the Office Action that JP 2001-015012 teaches the carbonaceous material projection structure according to claims 14 and 15 of the present disclosure. However, as stated before, JP '012 teaches that the projections are formed without the use of a mask. Rather, JP '012 discloses only one photolithography technique to form a mask and said mask is to form a gate, not a projection. Moreover, JP '012 teaches a series of needle-like projections 2 (see, Figs. of JP '012). As is clear, tips of the projections are not smaller than roots of the projections, nor are they conical in shape. Rather, they are linear in shape. Accordingly, JP '012 fails to teach or suggest the limitations of claims 14 and 15 of a plurality of carbonaceous material projections being formed by etching using a mask, the tips of the projections being smaller than roots of the projections; or that each carbonaceous material projection has an approximately conical shape.

Anticipation under 35 U.S.C. § 102 requires that each and every element of the claim be disclosed, either expressly or inherently in a prior art reference, *Akzo N.V. v. U.S. Int'l Trade Commission*, 808 F.2d 1471 (Fed. Cir. 1986). At a minimum, for the reasons set forth above, JP 2001-015012 does not disclose all of the limitations of amended claims 14 and 15. Therefore, as it is apparent from the foregoing that 2001-015012 fails to anticipate amended claims 14 and 15 or any dependent claims thereon, Applicants submit that amended claims 14 and 15 are allowable and patentable over the prior art. As such, Applicants respectfully request that the § 102 rejection of claims 14 and 15 be withdrawn.

### **III. The Rejection of Claims 9-18 Under 35 U.S.C. § 103**

Claims 9-18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over JP 2001/015012 ("JP '012") in view of Baik (Thin Solid Films 377-378 (2000) 29-302) and further in view of Cathey (USP No. 6,423,239) and Ageno (USP No. 5,449,435). Applicants respectfully submit that JP '012, Baik, Cathey and Ageno fail to render the pending claims obvious for at least the following reasons.

With regard to the present disclosure, amended independent claim 9 teaches a method of forming one or more carbonaceous material projections, the method comprising the steps of applying a resist onto a carbonaceous material substrate; forming holes in the applied resist, the holes being provided according to a predetermined arrangement, each hole having a wall surface, and the wall surface being inversely tapered from an aperture thereof toward a bottom thereof; depositing mask material for a mask on the carbonaceous material substrate to form a mask deposition in each hole; lifting off the mask material deposited on the resist together with the resist to form a mask, the mask having a shape of one selected from the group consisting of a circular cone and a circular truncated cone; and after the mask has been formed, etching the

carbonaceous material substrate by using the mask to form one or more carbonaceous material projections.

As was mentioned above, JP '012 fails to teach or suggest that the carbonaceous material projections are formed with a mask. Because of this, it follows that JP '012 fails to teach or suggest the steps of claim 9 of lifting off the mask material deposited on the resist together with the resist to form a mask, the mask having a shape of a circular cone or a circular truncated cone; and etching the carbonaceous material substrate by using the mask to form one or more carbonaceous material projections.

Baik fails to teach or suggest the limitation of claim 9 of using a mask with a circular cone or circular truncated cone shape to form carbonaceous projections. Fig. 1 of Baik shows an oxide mask, which does not have a shape of a circular cone or a circular truncated cone. As such, Baik fails to teach or suggest a mask having a shape of one selected from the group consisting of a circular cone and a circular truncated cone; and after the mask has been formed, etching the carbonaceous material substrate by using the mask to form one or more carbonaceous material projections.

It is alleged that Cathey teaches using a mask and resist system. However, as shown in Fig. 2-7 and discussed in col. 6, lines 28-32, the resist 32 is applied over the mask 30. As such, the resist is not “applied to the carbonaceous material substrate” as required in claim 9.

Moreover, Cathey fails to disclose a diamond structure and etching of diamond. Rather, Cathey teaches, in col. 5, lines 58-65, that undercut is formed in the cathode 13 during the etching with respect to the size of the mask.

Furthermore, Ageno does not remedy this deficiency. In Ageno, a first oxidized layer is formed, etched, and then a second oxidized layer is formed all under wet-etching conditions. Ageno is not directed to dry etching and as such, the combination of Ageno with JP '012, Baik and Cathey is improper. As such, it is clear that the combination of JP 2001-015012, Baik, Cathey and Ageno fails to teach or suggest all of the limitations of claim 9 or claim 13 of the present disclosure.

In addition, independent claim 13 recites a method of forming a carbonaceous material projection, the method comprising the steps of: forming a film on a carbonaceous material substrate, the film being made of one of a silicon-based nitride ( $\text{SiN}_x$ :  $0 < x < 1.33$ ) and silicon-based nitride oxide ( $\text{SiO}_x\text{N}_y$ :  $0 < x < 2$ ,  $0 < y < 1.3$ ); applying a resist onto the film formed on the carbonaceous material substrate, patterning the resist by one of photolithography and electron beam exposure to form a patterned resist of a dot shape, and processing the film by use of the patterned resist as a mask; and etching the carbonaceous material substrate by use of an etching mask including the processed film to form a carbonaceous material projection, an apex angle of the carbonaceous material projection being equal to or less than 39 degrees.

With regard to claim 13, JP '012 does not and is not relied upon to teach that the apex angle of the carbonaceous material projection is equal to or less than 39 degrees. It is asserted in the Office Action that given the density of the diamond tips taught by JP '012 and the height of the tips, then the apex angle would inherently be within applicants claimed range, or alternatively, would have been obvious to provide the angle. Applicants respectfully disagree. Again, as stated above, the projections and the method of making the projections of JP '012 are different than that of the present disclosure. Accordingly, one skilled in the art would not expect that the angle would be inherent. Rather, one skilled in the art would believe them to be

different, significantly. The Examiner's rationale stating that because the density is the same is not clear. As density of a material has nothing at all to do with its structure, one skilled in the art would not assume that they are related. Accordingly, the claimed apex angle of 39 ° or less is not taught by JP '012.

Moreover, Baik fails to remedy this deficiency. Rather, Baik discloses that an apex angle of the projection for an emitter is equal to or greater than 45 degrees and that the projection is formed by an SiO<sub>2</sub> mask. Since the Examiner asserts that one skilled in the art would readily combine these two references, it then follows that one skilled in the art would believe that the apex angle is 45 ° or greater. Moreover, Ageno and Cathey are not relied upon to remedy this deficiency, and even if they did disclose the claimed apex angle, the combination with Baik would be improper, as Baik teaches an apex angle of 45 ° or greater. Accordingly, it is clear that the cited prior art fails to teach the above limitation.

Moreover, as claims 14 and 15 have been shown above to not be anticipated by JP 2001-015012, and Baik, Cathey and Ageno do not and are not relied upon to remedy these deficiencies, it is clear that claims 14 and 15 are not rendered obvious by the cited prior art.

In order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. As is clearly shown, JP 2001-015012, Baik, Cathey and Ageno do not disclose the limitations of amended claims 9 and 13-15. Accordingly, Applicants submit that JP 2001-015012, Baik, Cathey and Ageno do not render amended claims 9 and 13-15 of the present disclosure obvious and as such, amended claims 9 and 13-15 are patentable and allowable over the cited prior art. Accordingly, Applicants respectfully request that the § 103(a) rejection of amended claims 9 and 13-15 be withdrawn.

**IV. All Dependent Claims Are Allowable Because The Independent Claim From Which They Depend Is Allowable**

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819 F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as claims 9 and 13-15 are patentable for the reasons set forth above, it is respectfully submitted that all pending dependent claims are also in condition for allowance.

**V. Conclusion**

Having fully responded to all matters raised in the Office Action, Applicants submit that all claims are in condition for allowance, an indication of which is respectfully solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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